

HERE'S HOW TO
INCORPORATE RISK
INTO YOUR NPV AND
IRR ANALYSES.

How Risky Are Your Capital Expenditures?

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What could possibly be new about net present value (NPV) and internal rate of return (IRR) analyses? For many decades, accounting and finance professionals have been using NPV and IRR measurements to evaluate capital expenditures. Typically, you develop estimates of future cash flows, time periods, and an appropriate discount rate to incorporate risk, and the spreadsheet does the rest. To do “what if” analyses, you change the periodic cash flow estimates and the discount rate.

But what if you need to analyze more complex capital expenditure situations with several future cash flow measures at different levels of risk for each cash flow estimate? The evaluation process is much more complex. You need to estimate future cash flows and incorporate intangible variables that may increase or decrease cash flows. To make a decision, you need to come up with a range of possible outcomes from the best case scenario to the worst case scenario of the capital expenditure.

Let's take a look at how to accomplish this task.

GUIDANCE FROM FASB

The Financial Accounting Standards Board (FASB) provides us with guidance on how to estimate the range of possible cash flows. The FASB's Statement of Financial Accounting Concepts No. 7, "Using Cash Flow Information and Present Value in Accounting Measurements" (CON 7), shows us how to build risk into measuring the present value of estimated future cash flows using weighted cash flow estimates. According to CON 7, risk is built into the measurement system by evaluating each future cash flow estimate.

Let's compare a traditional future cash flow measurement model with a CON 7 future cash flow measurement model within a present value analysis framework. In a

traditional future cash flow measurement, we'll assume a project has three years of estimated future cash inflows of \$1,000 each. To compute present value, the best estimate of \$1,000 for each year would be discounted at a specified discount rate based on the overall risk of the capital expenditure—the more risk there is, the higher the rate; less risk, less rate. This approach assumes the risk of the three years of estimated future cash flows is constant and can be captured in one discount rate—indeed a major assumption when the typical capital expenditure analysis incorporates several years and many different sources for estimated future cash inflows and outflows. Some estimates are reasonable, even concrete, while others can be soft and uncertain. Thus, it's unreasonable to assume that

Table 1: WEIGHTING CASH FLOWS

YEAR DESCRIPTION	Year 1			Year 2			Year 3		
Best estimate	\$1,000			\$1,000			\$1,000		
Possible alternatives									
A	20%	\$ 800	\$ 160	30%	\$ 800	\$ 240	20%	\$ 500	\$ 100
B	50%	1,000	500	50%	1,000	500	50%	1,000	500
C	30%	1,200	<u>360</u>	20%	1,200	<u>240</u>	30%	1,500	<u>450</u>
Weighted average	\$1,020			\$ 980			\$1,050		

Table 2: WEIGHTED CASH FLOW ESTIMATES FOR ACQUIRING AN ENTERPRISE RESOURCE PLANNING (ERP) SYSTEM

		BEST CASE WEIGHT	WORST CASE WEIGHT			BEST CASE WEIGHT	WORST CASE WEIGHT
INITIAL OUTLAY COSTS							
Hardware	\$ 2,000,000	1.0	1.0				
Software	400,000	0.9	1.1				
Conversion	<u>200,000</u>	0.8	1.2				
Total initial cost	\$ 2,600,000						
				YEAR 1		YEAR 5	
RECURRING COSTS							
Hardware expansion	\$ 50,000	1.0	1.0		\$ 260,000	0.7	1.4
Communication charges	100,000	1.0	1.1		160,000	0.8	1.2
Software updates	<u>300,000</u>	1.0	1.0		<u>420,000</u>	0.8	1.4
Total recurring costs	\$ 450,000				\$ 840,000		
SAVINGS							
Clerical cost savings	\$ 600,000	1.0	0.8		\$ 1,200,000	1.0	0.6
Warehousing efficiencies	<u>100,000</u>	1.3	0.9		<u>500,000</u>	1.1	0.7
Total savings	\$ 700,000				\$ 1,700,000		

Table 3: EVALUATING ASPECTS OF AN ERP EXPENDITURE

CATEGORY AND TYPE OF THE ESTIMATE	QUALITY OF THE ESTIMATE	EXAMPLE
1. External contract or request for proposal	High	<ul style="list-style-type: none"> ◆ Legal contract with a locked-in price, such as physical installation, hardware, software, outsource, or eliminated outsource functions.
2. Wages and benefits (controlled by management) 3. Productive use of working capital resources (controlled by management)	High to Medium	<ul style="list-style-type: none"> ◆ Additional information technology professionals. ◆ Fewer clerical staff for input, data management, and reporting. ◆ Fewer information technology professionals. ◆ Inventory: reduce inventory and increase turns with better information and logistics. ◆ Accounts receivable: identify a higher caliber of customer, and improve billing cycle. ◆ Accounts payable: take full advantage of discount with superior cash flow management.
4. Market and information interaction 5. Management's response to information—dependent upon system and several other controlled and uncontrolled variables.	Medium to Low	<ul style="list-style-type: none"> ◆ Increase sales and profits with superior customer service and interaction with market planning and advertising. ◆ Efficient and effective use of new, timely information, such as what inventory to purchase, segment profitability, performance reports, and budget analysis.

the discount rate can capture the risk associated with many estimates of future cash flows.

In contrast to the traditional NPV model, CON 7 builds risk into an analysis by weighting the possible range of cash flow estimates that may be applied in an investment decision. In our three-year project, let's give year one a 20% chance of receiving \$800, a 50% chance of receiving \$1,000, and a 30% chance of receiving \$1,200 for a weighted average of \$1,020, as shown in Table 1. Then we'll give years two and three weighted average amounts of \$980 and \$1,050, respectively.

Weighting the cash flows offers two distinct advantages. The first is that it introduces the expected range of estimated future cash flows into the model. The risk is captured in the range of cash flow estimates. The second is that you don't have to guess the discount rate. The discount rate used in a present value model, where the cash flows are weighted following CON 7, is the company's weighted average cost of debt and/or equity. That is, the discount rate isn't dependent upon the risk of individual projects. The rate can be set at a company-wide hurdle rate. As a result, you can use the same discount rate in all models, improving company-wide comparability.

CON 7 teaches us about weighting cash flows, significantly improving NPV analysis. CON 7 also shows that each estimated future cash flow must be evaluated on its own merits and adjusted for its possible range of outcomes. In doing so, the risk of each estimate is explicit, and evaluation of risk is at the source—the range of esti-

mated cash flows. To make those risks explicit, CON 7 says to compute the weighted average of each estimated future cash flow. Although this approach seems reasonable, it doesn't provide a workable, dynamic tool to support business capital expenditure analysis because there will be only one outcome measure while you ideally want a range of possible outcomes in an NPV or IRR analysis.

ENHANCING THE CAPITAL EXPENDITURE MODEL

A useful approach in a capital expenditure analysis is to establish a best case to worst case range of possible outcomes. This can be done by building a workable spreadsheet that considers two or more estimates for each projected cash inflow or outflow. From this, you'll be able to run a dynamic NPV or IRR evaluation of a capital expenditure, observing the range of possible outcomes, as illustrated in Tables 2, 4, 5, and 6. (More advanced capital expenditure models are commercially available, requiring the user to estimate probability distributions. But the advantage of the model in this article is it accomplishes the same task with less complexity.)

Let us illustrate. Our capital expenditure is for an enterprise resource planning (ERP) system. We've chosen an ERP expenditure because of the challenges inherent in evaluating the costs and benefits of this type of procurement. We'll give cash flow estimates for the initial investment and for years one and five, as shown in Table 2. We jump from year one to five to illustrate the value of a dynamic capital expenditure analysis. The process begins

Table 4: DATA FOR AN NPV AND IRR ANALYSIS OF A CAPITAL EXPENDITURE

Cost of Capital 8%
Investment Savings and Costs

INITIAL OUTLAY COSTS		BEST CASE WEIGHT	WORST CASE WEIGHT
Hardware	\$ 90,000	1.0	1.0
Software	400,000	1.0	1.1
Training	200,000	0.9	1.3
Site preparation	200,000	1.0	1.2
Initial systems design	2,000,000	0.8	1.2
Conversion	<u>200,000</u>	0.9	1.3
Total initial outlays	\$ 5,000,000		

Depreciation Tax Savings

Depreciation on initial investment of \$3,750,000

Tax Rate: 33.3%

YEAR	RATE	DEPRECIATION	TAX SAVINGS
1	33.3%	\$1,250,000	\$312,500
2	33.3%	1,250,000	312,500
3	33.3%	1,250,000	312,500

	YEAR 1	BEST CASE WEIGHT	WORST CASE WEIGHT	YEAR 2	BEST CASE WEIGHT	WORST CASE WEIGHT	YEAR 3	BEST CASE WEIGHT	WORST CASE WEIGHT	
RECURRING COSTS										
Hardware expansion	\$ —	1.0	1.0	\$ 260,000	1.0	1.0	\$ 300,000	1.0	1.0	
Software	—	1.0	1.1	150,000	1.0	1.1	200,000	1.0	1.1	
Systems maintenance	60,000	1.0	1.3	120,000	0.9	1.3	130,000	0.9	1.3	
Personnel costs	500,000	1.0	1.2	800,000	0.9	1.2	900,000	0.9	1.2	
Communication charges	100,000	1.0	1.1	160,000	1.0	1.1	180,000	0.8	1.1	
Overhead	<u>300,000</u>	1.0	1.0	<u>420,000</u>	1.0	1.0	<u>490,000</u>	0.8	1.1	
Total recurring costs	\$ 960,000			\$1,910,000			\$2,200,000			

SAVINGS

Clerical cost savings	\$ 600,000	1.0	0.9	\$1,200,000	1.1	0.8	\$1,400,000	1.1	0.8
Working capital savings	900,000	1.1	0.9	1,200,000	1.0	1.0	1,500,000	1.0	0.8
Profits from sales increases	—	1.0	1.0	500,000	1.1	0.8	900,000	1.1	0.7
Warehousing efficiencies	—	1.0	1.0	<u>400,000</u>	1.1	0.8	<u>800,000</u>	1.1	0.7
Total savings	\$1,500,000			\$3,300,000			\$4,600,000		

by placing the most likely estimated future cash flow for each line item into the model. Next, we estimate the best and worst case outcomes, represented by the weights applied. By weighting the outcomes, the risk evaluation is at the source and is explicit in the analysis.

Some estimates are relatively easy to determine while others are more difficult. Easy estimates typically include the initial outlay and estimates for outlays in the early years of the project. For example, the initial outlay for hardware, which comes from the purchase order, is assigned a weight of 1.0 in the best case scenario, shown in Table 2. If you don't have direct experience knowing what a particular cash flow estimate is or aren't confident in your cash flow estimate, then your range between the best case and worst case weights should be much wider. For example, under ERP data conversion in Table 2, we have a best case weight of .8 and a worst case weight of 1.2. This signals that we are less certain about the

\$200,000 estimate for the conversion. We use a similar approach for estimating recurring costs and savings, making the risk associated with each cash flow explicit by weighing each estimate.

TYPE AND RANGE OF EXPENDITURES

Taking capital expenditure analysis still further, let's look at how to work with the type and range of cash flow estimates for our ERP expenditure. While in Table 2 we illustrated the weighting concept in an NPV calculation, in Table 3 we evaluate critical aspects of our ERP acquisition.

To begin, we list and rank estimated future cash inflows and outflows by the quality of the estimate, shown in Table 3. That is, estimated future cash flow savings and expenditures built on reliable information should be listed first, and the riskier estimations should follow. For example, cash flow estimates from an external contract or request for proposal shouldn't vary as the

Table 5: BEST CASE NPV AND IRR ANALYSIS OF THE CAPTITAL EXPENDITURE

	INITIAL OUTLAY	YEAR 1	YEAR 2	YEAR 3
INITIAL OUTLAY COSTS				
Hardware	\$ 900,000			
Software	400,000			
Training	180,000			
Site preparation	200,000			
Initial systems design	1,600,000			
Conversion	<u>180,000</u>			
Total initial outlays	2,650,000			
RECURRING COSTS				
Hardware expansion		\$ —	\$ 260,000	\$ 300,000
Software		—	150,000	200,000
Systems maintenance		60,000	108,000	117,000
Personnel costs		500,000	720,000	810,000
Communication charges		100,000	160,000	144,000
Overhead		<u>300,000</u>	<u>420,000</u>	<u>392,000</u>
Total costs		960,000	1,818,000	1,963,000
SAVINGS				
Clerical cost savings		600,000	1,320,000	1,540,000
Working capital savings		990,000	1,200,000	1,500,000
Profits from sales increases		—	550,000	990,000
Warehousing efficiencies		<u>—</u>	<u>440,000</u>	<u>880,000</u>
Total savings		1,590,000	3,510,000	4,910,000
SAVINGS MINUS RECURRING COSTS				
		630,000	1,692,000	2,947,000
Less income taxes @ 25%		<u>(157,500)</u>	<u>(423,000)</u>	<u>(736,750)</u>
Cash savings (net of tax)		472,500	1,269,000	2,210,250
Savings on taxes due to depreciation deduction		<u>312,500</u>	<u>312,500</u>	<u>312,500</u>
Net savings		<u>785,000</u>	<u>1,581,500</u>	<u>2,522,750</u>
Present value of net saving	4,085,373	\$ 726,852	\$ 1,355,881	\$ 2,002,640
Net present value	<u>\$ 1,435,373</u>			
Internal rate of return		<u>21%</u>		

contract rolls out. Estimates based on a limited amount of information should reflect a wide range of possible outcomes. For example, cash flow estimates driven by management's response to information will be dependent upon how well the system works and several other controlled and uncontrolled variables and will likely vary as the contract rolls out. Thus, in reading and evaluating our ERP expenditure model, we expect to see a narrow range of outcomes in some estimates and a wide range in others. In addition, we should see a wider range in outcomes in later-year estimates in general because the ability to predict cash flows declines as the projection moves out into future periods.

Cost estimates in categories four and five in Table 3, market and information interaction and management's response to information, respectively, can be the most subjective. Certainly an accounting professional can generate information from data. But can senior management employ this information to capture market opportunities, such as increased sales from knowing how to better serve customers, or identify the most profitable customers, market segments, or product lines? The risk increases because capturing these benefits is dependent upon external market conditions that management may not control and by leveraging intangible and tangible company resources.

Table 6: WORST CASE NPV AND IRR ANALYSIS OF A CAPITAL EXPENDITURE

	INITIAL OUTLAY	YEAR 1	YEAR 2	YEAR 3
INITIAL OUTLAY COSTS				
Hardware	\$ 90,000			
Software	440,000			
Training	260,000			
Site preparation	240,000			
Initial systems design	2,400,000			
Conversion	<u>260,000</u>			
Total initial outlays	3,690,000			
RECURRING COSTS				
Hardware expansion		\$ —	\$ 260,000	\$ 300,000
Software		—	165,000	220,000
Systems maintenance		78,000	156,000	169,000
Personnel costs		600,000	960,000	1,080,000
Communication charges		110,000	176,000	198,000
Overhead		<u>300,000</u>	<u>420,000</u>	<u>539,000</u>
Total costs		1,088,000	2,137,000	2,506,000
SAVINGS				
Clerical cost savings		540,000	960,000	1,120,000
Working capital savings		810,000	1,200,000	1,200,000
Profits from sales increases		—	400,000	630,000
Warehousing efficiencies		—	<u>320,000</u>	<u>560,000</u>
Total savings		1,350,000	2,880,000	3,510,000
SAVINGS MINUS RECURRING COSTS				
		262,000	743,000	1,004,000
Less income taxes @ 25%		<u>(65,500)</u>	<u>(185,750)</u>	<u>(251,000)</u>
Cash savings (net of tax)		196,500	557,250	753,000
Savings on taxes due to depreciation deduction		<u>312,500</u>	<u>312,500</u>	<u>312,500</u>
Net savings		<u>509,000</u>	<u>869,750</u>	<u>1,065,500</u>
Present value of net savings	<u>2,062,795</u>	<u>\$ 471,296</u>	<u>\$ 745,670</u>	<u>\$ 845,828</u>
Net present value	<u>\$(1,627,205)</u>			
Internal rate of return	<u>-23%</u>			

NPV AND IRR RESULTS

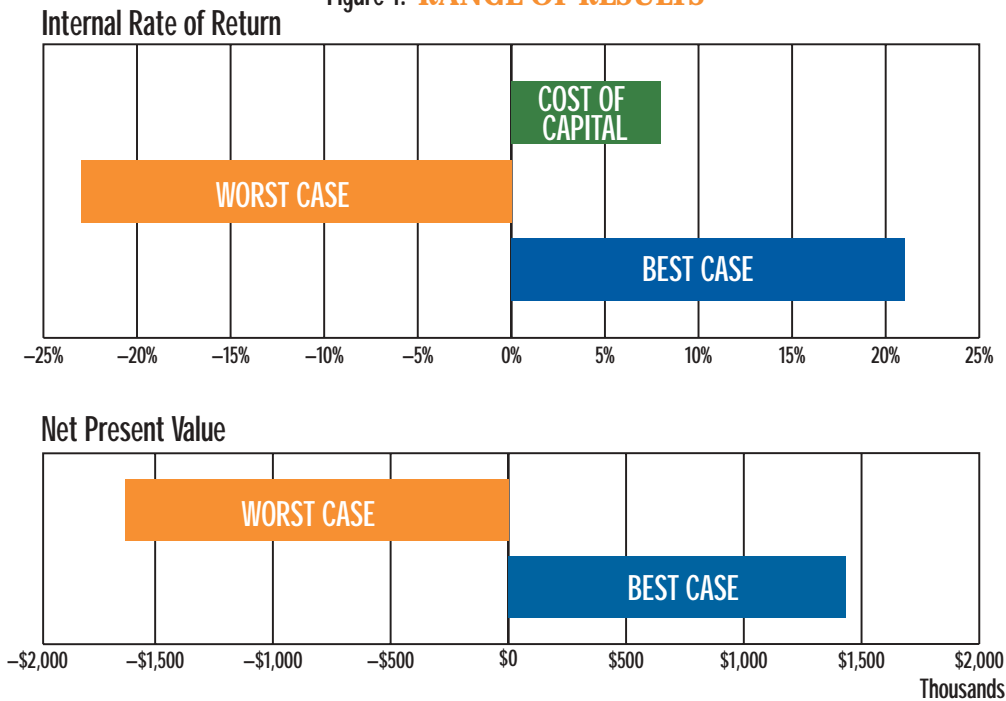
To make NPV and IRR a dynamic, what-if process, we begin designing a spreadsheet for the ERP expenditure by setting up four sheets: (1) a data section (Table 4), (2) best case scenario (Table 5), (3) worst case scenario (Table 6), and (4) a graph of corresponding NPVs and IRRs (Figure 1). (One of the authors of this article, Thomas L. Zeller, will give you this demonstration in an Excel spreadsheet if you e-mail him at tzeller@luc.edu and write in the subject line “NPV IRR analysis.”)

In Table 4 we have the data for a typical NPV or IRR analysis of our ERP procurement, and we’ve added

weights to incorporate risk for each estimated future cash flow. We suggest you pay particular attention to the larger dollar estimates throughout an analysis because they impact NPV and IRR the most. The listing of each category of future cash flows is by quality of estimate. For example, savings generated by reducing clerical staff is a more certain estimate than savings derived from warehouse efficiencies.

Noteworthy in Table 4 is the pattern of weights. Specifically, the weights begin to widen when moving from left to right and top to bottom. For example, observe how the weights in the row labeled “software” under recurring costs

Figure 1: **RANGE OF RESULTS**



half and the graphs in the other. Because the entire document is cell referenced beginning at the data section, the results of estimate changes can be observed immediately, making for a rich and dynamic evaluation of a capital expenditure analysis. This can help facilitate meaningful discussions, challenges, critiques, and changes in estimates about such things as dollar amount, timing, best case weight, and worst case weight. The end result is a range of possible NPV and IRR outcomes driven by a critical

analysis based on an interactive dynamic process.

in years two and three both have a range of 1.0 to 1.1. This signals that the range of possible cash flows is relatively stable. Support for such a narrow and consistent range of estimated cash flows would be a purchase order or legal contract, which we noted previously. Now observe the weights in the row titled “Warehousing efficiencies” under “Savings.” In year two the weights are best case of 1.1 and worst case of 0.8. The gap widens in year three to 1.1 and 0.7 because problems could occur and reduce savings opportunities, making the estimate riskier over time. If we were to estimate beyond year three, the gap between best case and worst case weights would logically widen still more.

Analyzing capital expenditures by building risk into individual elements that comprise estimated future cash flows is a much better way to evaluate and model potential outcomes. Theoretically, you don’t have to guess at incorporating risk. Capital expenditure analysis is too complex to employ only one estimate as a valid risk measure. Our suggested framework makes the source of risk and the possible range of outcomes explicit. As a result, you can do a much better job serving your internal customers. Take the framework, sit with your team, and efficiently and effectively evaluate possible outcomes for estimates, showing them the graphical output when different ranges of cash flows are debated and put into the model. This framework provides immediate feedback for evaluation and decision making—an important tool because the complexity and risk associated with capital expenditures is increasing. Substantial dollars are at stake, and you need to combine tangible and intangible resources to create wealth. ■

We built two other features into Table 4: the cost of capital and depreciation tax savings. The cost of capital, 8%, is noted in the upper left; and depreciation tax savings is shown in the upper right box. All values from Table 4 are linked by cell reference to Tables 5 and 6. That is, Table 4 is the only location where data is inputted and/or changed. Tables 5 and 6 provide best case and worst case scenario NPVs and IRRs, respectively.

Finally, we graph the outcomes in Figure 1. The net present value ranges from the worst case scenario, a \$1.6 million reduction in wealth, to a best case scenario of a \$1.4 million increase in wealth. The internal rate of return for this illustration ranges from -23% to 21%. These graphs can be useful when working through the estimates with management or the workforce. You can simply split the screen and show the data section in one

analysis based on an interactive dynamic process.

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